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Conceptualizing technological capabilities within global value chains

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ABSTRACT

Capitalist transformation is composed of many multifaceted processes, but growth in the size and capabilities of locally owned firms is essential. The AfriCap research project aims to understand how African-owned firms learn and build their technological capabilities in order to enter and remain competitive in new export sectors. The purpose of this first working paper is to advance our conceptualization of what it means to build capabilities within globalized industries. The paper draws on the conception of technological capabilities from the Technological Capabilities literature, but adapts it to the context of global value chains and the specific requirements demanded and capabilities needed in this regard. It does so by drawing on the Global Value Chain and Global Production Network approaches. This approach offers conceptual tools for understanding firm-level processes of learning and capability building as well as how these firm-level processes are influenced and shaped by the specificities of the industry and global value chain in which they operate, as well as the national institutional and policy context. The paper concludes by showing how this conceptual approach can be operationalized in the context of specific global value chains.

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African-owned firms building capabilities in global value chains (AFRICAP)

AFRICAP examines industrialization in African countries in the context of increasingly globalized production networks coordinated through transnational inter-firm linkages. African-owned firms often struggle to enter new export sectors in manufacturing and agro-processing, to remain competitive within them, and to capture greater value. AFRICAP focuses on firm-level capability building and combines this firm level analysis with an understanding of global value chains and national institutional factors. The project analyzes various channels that facilitate learning among firms: industrial policies, foreign direct investment linkages, and buyer-supplier relations within global value chains.

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For more information, go to our website: www.ruc.dk/africap.

AFRICAP
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Introduction

Economic growth has increased in many Sub-Saharan African countries since the mid-1990s, but did not lead to significant structural change of their economies because it was driven primarily by increases in international commodity prices, consumption, and government spending. Manufacturing is limited in many African countries, which also struggle to move beyond their traditional commodity exports. Capitalist transformation is composed of many multifaceted processes, but growth in the size and capabilities of locally owned firms is essential. The AfriCap research project aims to understand how African-owned firms learn and build their technological capabilities in order to enter and remain competitive in new export sectors. In the twenty-first century, late industrialization takes place increasingly through developing countries' firms participating in global value chains, rather than creating entire industries within their borders (Whittaker et al. 2010). Therefore, entering new export markets in manufacturing and agribusiness means entering globalized industries.

This working paper is the first in a series during the AfriCap research project. The project aims to advance our theoretical understanding of how and why African-owned firms build technological capabilities, and to develop new methodological approaches for measuring firms' capabilities and explaining their determinants. The purpose of this first paper is to advance our conceptualization of what it means to build capabilities within globalized industries. It does this by using the Technological Capabilities (TC) approach and combining it with insights from the Global Value Chain (GVC) and Global Production Networks (GPN) literatures.

In the AfriCap project, we operationalize the conceptual argument presented in this paper by outlining the technological capabilities that firms are required to have in the apparel and floriculture global value chains, at varying levels of functions and complexity, and how to measure them. We develop a matrix of capabilities for both apparel and floriculture, which is then used as the yardstick for measuring local firms technological capabilities in our case countries: Ethiopia, Kenya and Madagascar. Based on the matrices, survey instruments are developed that include questions aimed at capturing 'revealed capabilities'.[1] Locally owned firms in our sector cases are surveyed through face-to-face interviews. Using the survey results, we develop quantitative indicators of

[1] We agree with Newman et al. (2016) that capabilities are difficult to measure because they are hard to codify. Nonetheless, we have attempted to do this. While the result has weaknesses, it gets us much closer to analyzing the causal linkages between capabilities and performance than using broad measures of productivity as proxies for capabilities. We are also able to specify capabilities more precisely by moving to the industry and global value chain level.

different kinds of capabilities as well as an aggregate score of a firm's capabilities that are complemented by qualitative analysis that identifies different firm trajectories. The survey results from the four sector cases are presented in separate working papers. An additional working paper will discuss the methodological strengths and weaknesses of this approach to measuring technological capabilities, and our experiences with administering the survey.

Having identified what capabilities local firms in our sector cases have, the main focus of the AfriCap project is then to explain the determinants of firm-level capabilities. We are interested in the factors that explain why firms invest in new export sectors in the first place and why they put in technological effort to build capabilities, as well as why and when they are successful. In doing so, we are looking at how firm-specific factors shaping a firm's technological effort interact with and are shaped by sector, national and global value chain factors. How successful firms are in building capabilities is not only, or primarily, the result of firm-level factors but is shaped by business strategies of other firms, local and global sector dynamics, and institutional and policy contexts. Furthermore, we are concerned to understand the main channels through which learning takes place and their impact on outcomes in terms of firm-level capabilities. We expect these channels to include (1) inter-firm learning within global value chains, particularly from lead firms or intermediate buying agents; (2) foreign direct investment linkages, particularly sub-contracting but also the circulation of managerial experience and skilled labour; and (3) industrial policy by governments that assists and subsidizes technological effort by local firms. We examine the importance of these channels based on detailed firm histories of a select number of local firms constructed through in-depth interviewing with the staff of the local firms, relevant industry actors and government officials, foreign firms operating alongside local firms, and export buyers. The results of these will be presented in future working papers.

This first working paper sets the stage by giving an overview of the context and motivation of the AfriCap project. Second, it explains what technological capabilities are and how they have been conceptualized and operationalized within the TC literature. Third, it discusses how to think about technological capabilities demanded in specific global value chains by elaborating and adapting the TC approach. This leads, fourth, to a discussion of upgrading within the GVC and GPN literatures in terms how the concept has been used, some critiques of it, and the recent revisions in terms of how to think about upgrading, as well as pointing out overlaps between the concept of technological capabilities and the concept of upgrading. The fifth section suggests a synthesis of the TC and upgrading approaches that we will use in the project and which forms the basis of the broad template for describing technological capabilities required in a specific industry and global value chain. The last part concludes.

Context and Motivation of AfriCap

The AfriCap project is concerned with learning and capability building at locally owned firms because ownership matters. It is not enough for a developing country to attract foreign firms to operate and export from within its borders (Amsden 2009). National firms are the key mechanism through which economic development evolves, even though the sources of learning may often start with acquiring knowledge from foreign firms. We define national ownership broadly. Locally owned firms are not just those where the owner is an official citizen of the country, but also include firms where the owner or owners have been present in the country for a significant period of time and consider it home, even if they do not hold a passport for the country. We refer to these firms as diaspora-owned local firms, and they are embedded within the country in similar ways to indigenous-owned local firms. Foreign direct investment is important to bring capital, employment and knowledge opportunities into African countries, but spillovers cannot be generated and sustained unless locally owned firms emerge, learn and become competitive. External conditions change, such as access to preferential trade agreements, which cause many foreign firms to pack up and leave. This happened in Madagascar when it lost its trade preferences in the US market under the African Growth and Opportunity Act (AGOA) in 2009, leading most Asian transnational producers in the apparel sector to leave. Furthermore, success with foreign direct investment in labor intensive manufacturing and agribusiness sectors can undermine itself, as increasing employment leads to rising wages. Foreign firms may leave, searching for the next low cost location, but locally owned firms tend to stay and increase their capabilities in the same sector or move into a new one, bringing their existing capabilities with them.

Local firms in industries new to African countries are initially uncompetitive in export markets due to their low productivity. Low productivity stems from two types of constraints.[2] First order constraints on productivity relate to factors outside firms that lead to high production costs but which are costly or impossible for individual firms or farms to address on their own. These first order constraints include the high cost and poor terms of finance, poor state of physical infrastructure (power, water, transport, communications), the absence of skilled labor and the cost of acquiring or training labor, problems in accessing land and insecurity of land rights, and insufficient or inadequate inputs available in the country. This is the typical situation in most African countries, and these features are defining characteristics of developing economies.

Second order constraints relate to factors inside firms and have to do with what are called technological capabilities. Technological capabilities are knowledge-based assets. They are the technical, managerial, and organizational skills—soft technology—that allow firms to utilize equipment and scientific knowledge—hard technology—efficiently and

[2] The terminology of first and second order constraints was adopted from Vrolijk (2016).

profitably. Technological capabilities are inherently composed of tacit knowledge, and thus can only be acquired through learning-by-doing. But learning-by-doing is costly and risky. Firms have to undergo a period of learning in which they may operate at a loss, and it is uncertain if and when a firm may become competitive. The risk is highest for the first investors, when the knowledge and infrastructure required to become competitive in new economic activities do not yet exist and have to be acquired and adapted to local conditions. The effort that firms put into building their capabilities and the risks they are willing to take are highly sensitive to the incentive environment, the costs of investment, the availability of skills, technical information and support from other national actors, and interactions with related firms (Lall 1996: 31). Thus, national and industrial institutions shape firm-level effort and success in building capabilities, and thus increasing productivity to a level that makes them competitive.

African-owned firms must generally build a higher level of capabilities in order to enter export markets than to produce for the domestic market, and the high degree of competition in export markets makes the acquisition of such capabilities mandatory.[3] The AfriCap project focuses on African-owned firms in the apparel and floriculture export sectors, because African countries have had the greatest success in these non-traditional export sectors over the past couple of decades. In particular, the research includes four sector cases: the floriculture export industry in Ethiopia and in Kenya; and the apparel export industry in Ethiopia and in Madagascar.

The apparel and floriculture export markets are globalized industries: they are characterized by the globalization of production organized around lead firms and spatially dispersed networks of suppliers. It is not only cheap labor that allows low-income countries to become new sites of production in these global value chains. Competitiveness depends on production costs, most importantly wages in labor-intensive export sectors, but also on the productivity of labor that is determined by capabilities. The focus on cost-based competition (particularly low wages) as the driving force of dispersion of global production and global value chains has downplayed the flip side of the coin: the capabilities of firms (see also Khan 2009; Coe and Young 2015). African-owned firms, which typically have limited or no experience in a sector new to a country, have to acquire significant new capabilities, master them and adapt them to local conditions just to enter the low cost-low capabilities segment of global value chains. Despite low wages, these firms can fail to achieve a level of productivity and quality to even enter this low cost-low capabilities segment. This is because a major aspect of capability building in labor-intensive industries, such as apparel and cut-flowers, is the ability to organize and manage the firm's labor force. Increasing labor productivity is the outcome of firm-level organizational capabilities, as well as industry and national level factors such as the

[3] We recognize, however, that the large degree of trade liberalization characterizing most African countries means that locally owned firms must also compete with imported goods on the domestic market, and thus requires higher capabilities than domestic markets with trade protection.

limited availability of trained labor and high labor turnover that lead to high costs of managing and keeping skilled labor. In other words, even the low cost aspect is a determinant of firms' capabilities.

Technological capabilities are not only at the heart of what makes local firms competitive globally, but also are the building blocks of structural change of the national economy. This is because they are cumulative and lay the foundation for diversification into related products and new industries. Economic development can be understood as 'learning-based structural change': the 'progressive acquisition of largely country-specific and internationally immobile intangible capital in the form of personal and organizational skills and related institutional structures' which allows firms and industries within countries to adopt and develop process and product technologies of increasing complexity (Bell and Pavitt 1995: 90).[4] A dynamic and growing sector has positive externalities for other sectors in the economy through forward and backward linkages, and results in a general increase in managerial experience, production know-how and project execution skills as well as the creation of a skilled labor force and improvements in industry and trade-related infrastructure (Amsden 2001).

The TC approach offers conceptual tools for understanding firm-level processes of learning and capability building, and how these firm-level processes are influenced and shaped by industry-wide dynamics and inter-firm relations as well as by the national institutional and policy context in which they take place. But it also has weaknesses, as the approach has not been adapted to the changing global economy and nature of exporting through global value chains. The challenge is to contextualize firms building their technological capabilities within specific global value chains.

Frameworks that focus on understanding the implications of the changes in global production on supplier firms, on the other hand, have not focused on the firm level process of building capabilities. The GVC literature provides insights on global value chain governance, on lead firms' production and sourcing strategies, and on international standards, but these factors alone cannot explain why firms in African countries struggle to enter new export sectors, to remain competitive within them, and to capture greater value. Similarly, the GPN framework, including its latest version presented as GPN 2.0 by Coe and Yeung (2015), provides an overarching framework for thinking about how global production networks function and impact on development prospects, but it is not a framework that can explain what factors affect the costs and capabilities of supplier

[4] Alice Amsden (2001) makes a similar argument. She defines economic development as essentially a process of moving from a set of assets based on primary products exploited by unskilled labor, to a set of assets based on knowledge exploited by skilled labor. A knowledge-based asset is a set of skills that allows its owner to produce and distribute a product at or below prevailing market costs (or above prevailing market prices). These skills are both managerial and technological in nature, and they are hard to access because knowledge is not freely available: it is firm-specific and kept proprietary. Amsden's knowledge-based assets are the same as technological capabilities.

firms. As Morrison and colleagues (2008: 4) point out, 'how can one avoid a central focus on the endogenous process of technological capability development, on the specific firm-level efforts and on the contextual factors enhancing and/or hindering the process?'.

What are Technological Capabilities?

'If technology were simply a matter of information, competitiveness would be relatively easy to achieve and sustain, and catching up economically would be much less difficult than it has been' (Bell and Pavitt 1995: 74). It is on this point where evolutionary economic approaches to economic development differ fundamentally from neoclassical ones. The evolutionary approach stresses that technology is not readily transferable among firms and across countries, because it consists of bundles of information that are both codified and tacit. The operation of existing technologies as well as innovation require tacit knowledge that is highly specific to particular products, processes, firms, and markets, and thus can only be acquired through the accumulation of experience in particular contexts. Such an approach sees the firm as consisting of routines based on capabilities that are established over time, through trial and error, incremental changes, learning by networking, copying and imitation, and recruiting employees from competitor firms. But routines are not stable and capabilities have to change. Firms are therefore in a continual state of transforming capabilities as they try to respond to the emergence of new products, technologies, and alterations in consumer or buyer demands.

We use the definition of technological capabilities as a firm-specific form of institutional knowledge composed of the combined skills of its staff members accumulated over time (Lall 1996: 28-29). They are the organizational and operational skills that firms need in addition to formal education and scientific knowledge in order to function as an enterprise and to achieve the productivity level to be competitive. Simply providing equipment and operating instructions, patents, designs, or blueprints does not ensure that the technology will be used efficiently: that firms can achieve the level of productivity that established firms have achieved and which set the market standard. For example, a brand new firm composed of staff with little experience that takes over a turnkey operation in Ethiopia's floriculture sector will find it difficult to operate profitably at the beginning and may never become profitable. That is because the skills required to operate a firm involve knowledge that can only be acquired through experience, learning-by-doing, and problem-solving. Repetition in an action leads to productivity gains, but in addition to this passive learning, firms must put in 'technological effort' (Lall 1992). This includes, for example, in garment manufacturing, experimenting with work organization and flows, supervision practices, on the floor training, worker incentive schemes, quality check systems, information monitoring systems in order to achieve the quality and productivity that makes a firm a competitive supplier in the apparel global value chain.

Evolutionary economics theory of the firm, in contrast to neoclassical economics, argues that the efficiency of a firm comes from learned routines (Nelson and Winter 1982). Tacit knowledge comes from the routinization of activity. Information is stored primarily in the memories of members of the organization, 'in which reside all the knowledge, articulable and tacit, that constitutes their individual skills and routines, the generalized language competence and the specific command of the organizational dialect, and above all, the associations that link the incoming messages to the specific performances they call for' (Nelson and Winter: 104). The memories of individual members store so much of the information required for the performance of organizational routines, but those individual memories are linked by shared experiences in the past: 'experiences that have established the extremely detailed and specific communication system that underlies routine performance' (105). Innovations in organizational routine consist of problem-solving activity (breaking routines), but even problem-solving activity is based on experience with previous problem-solving efforts of that organization and thus embedded in the firm's past routines (126). In sum, routines are the skills of an organization; they are not deliberate choices, but capabilities: 'much of the knowledge that underlies the effective performance is tacit knowledge of the organization, not consciously known or articulable by anyone in particular' (134).[5]

A firm entering a new industry must imitate the routines of existing firms in order to become competitive. If the firm does so with the help of the imitatee, then this is referred to as technology transfer (Nelson and Winter 1982: 123). If it must do so without the help of the imitatee, this is the process of emulation: duplicating the imperfectly observed process from a distance. The more tacit knowledge involved in the routine, the more difficult this is to do successfully. The firm must fill in the gaps by independent effort, or hire employees from the imitatee. It is the tacit knowledge that constitutes a significant part of what is known as barriers to entry. Tacit knowledge is not easily imitated by or transferred across firms. The organizational structure that will work in a particular sector and country can only be discovered through trial and error with arrangements that slowly become unconscious routines (Khan 2009: 12).

This learning and adaptation process can be costly and uncertain (Lall 1993; Khan 2009). It is costly because learning requires investors to finance a period of implicit loss-making, and it is never clear from the outset how long it will take to learn and thus raise productivity to the level required to be internationally competitive. There is no predictable learning curve down which all firms travel (Lall 1996: 31). This is even true for relatively low quality and basic production processes. Therefore, a new firm can find entry into even basic production blocked. Furthermore, when the technology is not only new to a firm, but new to a country, the firm cannot hire workers with the relevant skills and experience, as these skills may not be available locally. Therefore, firms in new export

[5] In making this point, Nelson and Winter (1982) drew on the work of Karl Polyani.

sectors may have to import expertise in the form of consultants or expatriate workers. Even with the requisite skills formally available through training institutes, workers and managers have to acquire the tacit knowledge through on-the-job experiences. This is why pioneer firms often face the greatest costs and risks, and also why the second generation of investors poaches the employees and managers of existing firms.

However, technological capabilities constitute not only routine production capacity that a firm requires to function efficiently, but also capabilities to constantly improve techniques through technical and organizational change. The real world is constantly changing—market conditions change, as do consumer tastes, technologies improve, new competitors appear, costs of inputs change, and so on (Lall 1993: 723). Staying competitive requires continuous investment in skills, gathering information, organizational improvements, and linkages with other firms and institutions. Thus, building technological capabilities is a continuous process to absorb and create technical knowledge, through search and improvement efforts (Lall 1992: 166).

Firms' investments in technological capabilities are highly sensitive to the incentive environment, the cost of investment, and the available resources (Lall 1996: 31). Therefore, certain countries can experience more rapid capability building in local firms than others because of their national and industry-specific policies and existing stock of skills. Furthermore, firms do not develop capabilities in isolation; rather building capabilities are facilitated by a dense network of formal and informal relationships with suppliers, customers, competitors, consultants, research, and educational institutions (32). These firm-level and institutional linkages are important for firm-level learning. But capability development differs also across firms (Lall 1993: 723). Firms in the same industry can operate at quite different levels of capabilities, even with the same technology, and thus operate at different levels of efficiency (Biggs et al 1995: 18). One reason for this is because firms make idiosyncratic changes and progress in individual ways. But there is also the difference in firms that engage in building capabilities through constant search, and those who do not, or do so at a slower pace.

Conceptualizing Technological Capabilities

There is a basic core of functions that have to be internalized by the firm ('made routine') to ensure successful commercial operation (Lall 1992). The basic core grows over time as the firm undertakes more complex tasks and as it continues to absorb and create technical knowledge. Lall (1992) categorizes technological capabilities using a matrix generated by two classificatory principles: the functions that firms need to perform, and their degree of complexity. The functions that he singles out include investment, production, and linkage capabilities, which he recognizes can be interrelated and partly

overlapping. This matrix was adopted and adapted by Bell and Pavitt (1995). The matrix produced below in Table 1 is a synthesis of the ones used in the two works.

Investment capabilities refer to the skills required before and during investment: 'the skills needed to identify, prepare, obtain technology for, design, construct, equip, staff and commission a new facility (or expansion)' (Lall 1992: 168). They determine the capital costs, the appropriateness of scale, product mix, technology and equipment selected, and the 'understanding gained by the operating firm of the basic technologies involved, which in turn affect the efficiency with which it later operates the facility' (ibid). Basic elements of existing technology that are incorporated into new production facilities are often improved or adapted to specific situations, and making these changes is a complex and creative process (Bell and Pavit 1995: 85). For example, in turnkey operations in which the recipient firm does not participate, the firm may find it difficult to master and subsequently to adapt or improve the technology (Biggs et al 1995: 20).

Production capabilities refer to the skills necessary for the efficient operation of a factory (or other production unit) with a given technology, and its improvement over time (Morrison et al. 2008: 42). Lall (1992) provides a sub-categorization here, referring to process, product, and industrial engineering capabilities. The kind of skills involved include quality control, operation and maintenance, inventory management, monitoring of productivity, to more advanced ones such as adaptation and improvement of technology, and up to process and product innovation related to research activity. Bell and Pavitt (1995) use different sub-category names—product centered, and process and production organization—but refer to the same kinds of activities. Another aspect of production capabilities relates to capital goods: the ability to create machinery rather than import it, and even to produce it with new specifications rather than just imitate. This is an advanced capability, but was an important aspect in developed countries in terms of developing capital goods sectors out of agribusiness industries which began to build their own machines, such as in the US (Bell and Pavitt 1995; Schwartz 2010).

Linkage capabilities refer to linkages with other firms, input suppliers, sub-contractors, buyers, consultants, service providing firms, and relevant national institutions. By linkages, Lall (1992) is referring to the skills needed to transmit and receive information, skills, and technology from these other organizations, which increase the productivity of the firm. These linkages also allow for the diffusion of technology through the economy. Bell and Pavitt (1995: 87) emphasize the importance of collaborative arrangements among competing as well as complementary firms. Thus, firms can learn new capabilities from their buyers, but they can also learn from their suppliers (of various inputs) or induce them to make improvements in those inputs. Learning from machinery and equipment suppliers has been identified as an important learning channel in apparel firms in several African countries – often more important than learning from buyers. But also learning from or together with firms involved in the production of same products is important,

particularly in the context of clusters and for smaller local firms in developing countries. Specifically linkages (as well as other) capabilities may require a certain size that can be achieved through collaboration and joint efforts and actions.

It is useful to combine this notion of linkage capabilities with arguments from evolutionary economics on the importance of achieving relational stability in markets as central to a firm's survival as well as its advancement. In addition to production and investment capabilities, making market connections requires the production of stable socio-material relations with workers, suppliers, buyers, consumers, and the state (Ouma 2012: 325). Thus, firms need to work toward stabilizing intra- and extra-firm relations, rather than just pursuing efficiency. This is even more important in the context of production taking place within global value chains, as production is more fragmented requiring the management of more linkages and relations and given the central role of lead firms in setting requirements and standards that not only involve production but also the use of specified input suppliers (for example through approved vendor lists). Forging stability in relations with suppliers, buyers, and national agencies and institutions could be considered under linkage capabilities, while relations with managers and workers within the firm could be considered under production capabilities.

For each category of capabilities, Lall (1992) distinguishes the degree of complexity from basic to intermediate to advanced, corresponding to the following typology: simple and routine (experience based), adaptive and duplicative (search based), and innovative and risky (research based). Lall's work became the most influential in terms of conceptualizing and categorizing technological capabilities. Many authors have used his matrix, often revising it slightly, and operationalizing it to fit the specific sector and country under study.

The body of literature on technological capabilities offers useful ways to move from the abstract notion of technological capabilities, to conceptualize capabilities in terms of different categories and varying complexity within the categories, to concrete descriptions of the capabilities demanded in particular industries. However, the categories of capabilities used in this literature do not capture all of the capabilities required for export through global value chains as they have evolved in the twenty-first century.

In addition to costs, quality, and reliability of delivery, other criteria are particularly important in the context of global value chains and shape global buyers' sourcing decisions. They include most importantly (i) time criteria such as rapidly declining lead times and increasing flexibility which requires differently organized production processes, (ii) requirement of non-manufacturing capabilities such as input sourcing, product development, inventory management and stock holding, logistics, and financing, and (iii) compliance with safety, labor, and environmental standards which has become a minimum criterion for entering and remaining in many global value chains. In relation to

specific types of goods, there are often very specific buyer demands on production processes and products stipulated in detailed standards. Buyers often specify the exact characteristics of what their suppliers should produce and how they should produce it. In this context, different types of private and public standards have become a major determinant of global value chain access (Kaplinsky 2010).

These shifts in requirements and sourcing policies can be seen across sectors, but are articulated to different degrees related to sector specificities, types of lead firms, and complexity and time-sensitiveness of specific products. For example, in the apparel sector, buyers increasingly source from firms that exhibit the following capabilities: short lead times of several weeks (in contrast to the earlier several months); additional functions outside apparel assembly such as input sourcing, product development, logistics, and financing; and compliance with buyers' code of conducts comprising safety, labor, and environmental standards. In agro-food global value chains, to be able to enter means meeting strict logistics and lead times requirements; delivering consistent and reliable supplies; supplying sufficiently large volumes; and complying with particularly food safety standards set by buyers or import country regulators (Ponte and Ewert 2009). Standards in the cut-flower industry in contrast focus on social and environmental issues (Riisgaard 2011). Being able to communicate and link with buyers as well as suppliers has become more important in all sectors. Particularly, establishing connections and interacting with lead firms is a prerequisite to enter global value chains and get access to end markets, as market access is defined by lead firms which set the requirements and standards.

In this context, entry barriers for participation in global value chains have increased, including in basic labor-intensive industries traditionally seen to require quite low capabilities, such as apparel assembly and agro-processing. Particularly the rise of standards has resulted in raising the bar of market entry requirements, and thus supplier firms have to have higher technological capabilities to even enter export markets. Lead firms across sectors tend to have focused on core suppliers and higher demands with regard to manufacturing but also other capabilities, detailed performance monitoring of existing suppliers, and stringent selection principles for new suppliers. Lead firms also increasingly prefer one-stop shopping locations where they can source a variety of products and inputs. Through these developments, a process of consolidation has been underway across a large spectrum of sectors with fewer firms and countries performing a wider range of tasks. This has made it more challenging for African countries with large supplies of unskilled labor to participate in labor-intensive manufacturing and processing activities in global value chains. However, besides these general trends there are exceptions of certain lead firms that pursue different requirements and sourcing policies that could provide an entry point or a niche for new suppliers. This has been seen as relevant in the Ethiopian apparel sector and highlights the relevance of understanding the specificities of certain lead firms and value chains.

Therefore, we need to adapt Lall's illustrative matrix of technological capabilities to reflect the kinds of capabilities demanded in specific global value chains. The discussion of upgrading in the GVC and GPN literatures is pertinent in this respect. There are some areas of overlap in the conceptualization of upgrading and technological capabilities, as well as areas where both approaches can learn from each other. Furthermore, the increasing critical literature on traditional ways of conceptualizing upgrading has many important insights to contribute to thinking about firm level technological capabilities.

Upgrading in Global Value Chains

Most generally, upgrading is defined as the process by which economic actors – countries, regions or firms – improve their positions in the international hierarchy of value-added activities, moving from low-value to high-value activities to increase the benefits (e.g. security, value added, profits, wages) from participating in global value chains (Bair and Gereffi 2003). Initially, the concept of upgrading was used to describe the development trajectories of export-oriented countries and regions as they seek to change their export role in the international hierarchy of value-added activities. The focus subsequently shifted towards the industry and firm level to analyse the position and capabilities of firms in developing countries. In this context, upgrading aims to describe the ways in which firms must change their operations in order to maintain or improve their position in the global economy (Humphrey and Schmitz 2000). Upgrading is generally defined as the ability of producers 'to make better products, to make products more efficiently, or to move into more skilled activities' (Pietrobelli and Rabellotti 2006: 1).

Humphrey and Schmitz (2001, 2002) proposed an influential four-fold classification of upgrading that is commonly used, but has also been revised and expanded to include additional categories (Staritz 2012: 9; Ponte and Ewert 2009: 1638):

(1) *Process upgrading*: achieving a more efficient transformation of inputs into outputs through improving technology and/or production systems and procedures.
(2) *Product upgrading*: moving into more sophisticated, complex, and higher quality products with increased unit value.
(3) *Functional upgrading*: increasing the range of functions or changing the mix of activities in ways that increase the skill content of activities and thus involve higher-value tasks.
(4) *End market upgrading*: diversifying to new buyers or new geographic or product markets.
(5) *Supply chain upgrading*: establishing backward linkages within the supply chain.
(6) *Inter-chain (inter-sectoral) upgrading:* using competences acquired in one chain to move into a different more technologically advanced chain.

The upgrading concept in the GVC and related literatures adds to the classical firm-level perspective where competitiveness is generally seen in terms of process and product upgrading. In the GVC literature, it is stressed that while production efficiency and quality is a necessary condition for accessing and remaining in global value chains, functional upgrading, which involve repositioning in value chains and entering different value-adding activities within existing or new chains, puts the focus on specific segments of value chains that offer higher value added and rewards, rather than simply focusing on efficiency and quality improvements and being locked into low-value activities (Giuliani et al. 2005). Functional upgrading also goes beyond a focus on production, recognizing that value is created through a variety of non-manufacturing activities such as design, branding, logistics, and distribution as well as factors such as variability, reliability, responsiveness, flexibility, and adaptability. Firms may also attempt to capture more value by diversifying or moving to new buyers and markets, referred to as end market upgrading, or by strengthening backward linkages through supply chain upgrading (Frederick and Staritz 2011).

A main advance of the GVC and related frameworks is that upgrading not only depends on the level and depth of firms' skills and capabilities, and the policy and institutional context at different levels, but also on the type of value chain in which firms are inserted, and in particular the governance structure of chains, including their specific technological regimes and power dynamics that are crucially influenced by lead firms. Governance structures determine the power relationships among the different actors involved in the chain and the flow and allocation of resources within chains. Hence, they determine the prospects of firms to access global value chains and how the benefits and risks of participation are distributed along the chain (Gereffi 1999; Gereffi et al. 2001; Gereffi et al. 2005; Kaplinsky and Morris 2001). Lead firms control governance through their control over product specifications, technical standards, and broad cost and performance structures according to which global industries operate. But besides these technical relationships that constitute lead firm power in global value chains, also social, cultural and political dimensions of power shape lead firms' business strategies and the governance structures of value chains (Levy 2008; Morris and Staritz 2014; Morris et al. 2016).

The vast theoretical and particularly empirical contributions in the GVC and related literature shows that lead firm governance strategies can both enable and constrain firms' learning and upgrading prospects in global value chains (Humphrey and Schmitz 2001, 2002). It is generally accepted that it is easier for suppliers in global value chains to upgrade within production through process and product upgrading along the dimensions of productivity, quality, reliability, and flexibility, and that lead firms and buyers may also – to different extents - support this type of upgrading (Tokatli 2013: 994). Suppliers learn through the need to comply with lead firms' stringent requirements and standards, or lead firms may also support learning, particularly improvements in production

processes and products that lead to higher productivity and product quality in their value chains. Functional upgrading is often more contested as it involves taking over higher skilled and valued added functions. Lead firms have the potential to block suppliers' attempts to reposition themselves in chains, particularly in relation to moving into higher value added and more knowledge-intensive chain activities that lead firms see as their core competencies (Kaplinsky and Morris 2001; Kaplinsky 2005).

Hence, by bringing in the GVC literature, we can link technological capabilities with upgrading in global value chains as well as add another determinant to the factors explaining firm level capability building in addition to firm specificities and the national policy and institutional context, namely the dynamics and governance structures of particular value chains and their lead firms. With regard to the GVC literature and particularly the upgrading concept, bringing in the TC literature allows opening up the 'black box' of the supplier firm that is seen as rather passive in the upgrading process – in stark contrast to the strategies of lead firms. In part related to that, there are some challenges with the upgrading concept that need further discussion and clarification in order to link it to the technological capabilities approach. Two main and related issues that are most prominently – but not only - discussed in the GPN literature are:

(i) Is upgrading always linked to positive outcomes?
(ii) Complexities of upgrading: deepening, diversifying, and moving up or down?

Is upgrading always linked to positive outcomes?

Even though the upgrading concept is broadly used in GVC and GPN research and there is a convergence on the general conception outlined above, it is not always clear what is understood as upgrading. This refers specifically to the questions of whether upgrading is perceived as a process or as an outcome, and whether upgrading is only related to positive outcomes in terms of higher incomes and/or more security or also to potentially negative outcomes such as lower incomes and/or less security. This can be seen in the broadest definition of upgrading as 'improving the positions in the international hierarchy of value-added activities to increase the benefits from participating in GVCs' (Bair and Gereffi 2003). But what if increased benefits are related to downgrading? Hence, there tends to be a certain tautology problem that every beneficial outcome is attributed to upgrading.

Most of the GVC and GPN literatures conceives of upgrading as moving into activities considered as being higher value added: those which are better remunerated and have higher entry barriers because the skills required are more difficult to replicate (Navas-Aleman 2011: 1388). There is an implicit assumption that firms 'move up the value chain': performing functions in a global value chain that have more skill and knowledge content (Ponte and Ewert 2009: 163). Other scholars link upgrading more to innovation

but have a similar perspective: seeing upgrading as the capacity of a firm to innovate to increase the value added of its products and processes (Giuliani et al. 2005: 550). But what if these products and functions with higher skill, knowledge, and innovation content also bring with them higher risks that are not compensated by sufficiently higher incomes or other rewards?

We address this by differentiating between firm-level upgrading paths and ultimate outcomes defined as higher incomes and more security. This allows for the possibility to capture situations where upgrading leads to improved benefits but also where it leads to no benefits or, even worse, increased costs or other burdens. It also allows for downgrading being linked to improved benefits. This is specifically important in terms of product and functional upgrading. Process upgrading, in contrast, is probably always the better strategy than process downgrading which means declining efficiency and productivity of production processes. But there is often an implicit assumption that higher value added products and functions, as well as end markets, are always the better strategy without taking into account the firm-specific context and related risks and rewards.

In this vein, Ponte and Ewert (2009) argue for the analysis of rewards and risks to be incorporated into the study of upgrading. Gibbon (2008) talks about creating a new vocabulary of upgrading terms, and suggests that instead of using process, product and functional, it may be better to identify structures of rewards available to suppliers within specific chains, and concrete roles releasing these rewards. Tokatli (2013) concludes that we should be trying to measure the different capacities for profit making and capital accumulation among firms, and not necessarily upgrading. Similarly, Coe and Yeung (2015: 167) focus on value capture trajectories of firms, which are 'much more varied, contingent, and multidirectional than is seemingly implied in the common notion of economic upgrading'.

We do not say that upgrading to higher value products, functions, and end markets is not often necessary and required in the development process of firms and countries, not least because buyers in global value chains demand this as minimum criteria to enter and remain in their chains. Rather, we are arguing that an analysis of these processes needs to analytically and empirically disentangle upgrading paths from outcomes, in order to open up the possibility to capture diverse real world patterns and dynamics of upgrading experiences in specific value chains, countries and firms.

Furthermore, we agree that upgrading is a relational outcome, which means that it depends on what other firms are doing at the same time. If all firms upgrade, then the result is no longer an increase in reward (profit) because it depends on relative resources. This line of thought follows from a Schumpeterian view of the firm, and is similar to the discussion of rents within the GVC literature. What matters is how fast a firm is improving and innovating compared to competitors (Kaplinsky and Morris 2001). As

Kaplinsky (2005) and other scholars such as Schrank (2004) have argued, upgrading necessarily entails 'doing something that others cannot do', in other words where competition is limited or lower. As capabilities spread across countries, or as firms in developing countries seek to 'upgrade' at the same time to new functions, the returns to operating at the new function are diminished. Rather, these capabilities may become the new industry standards for suppliers and may not lead to extra rewards (see also Gibbon and Ponte 2005; Ponte and Ewert 2009; Plank and Staritz 2013, 2015; Tokatli 2013; Coe and Yeung 2015; Pickles et al. 2016).

This is the case for functional upgrading to certain activities such as input sourcing in the apparel sector, which are not the basis for extra rewards when full package production is the new industry standard. The same is true for certain standards becoming general market standards in agribusiness sectors, rather than niche market requirements, and hence do not attract a price premium (UNECA 2013). More generally, as standards have increased in importance to enter and remain in global value chains they forced particular forms of process and product upgrading onto suppliers but without necessarily leading to higher rewards. Furthermore, certain functions and responsibilities may also be off loaded onto supplier firms because lead firms no longer consider them as part of their core competencies. Such functional upgrading looks quite different than the usually assumed suppliers 'wresting' higher value added functions from lead firms (Tokatli et al. 2008: 277; Bair 2005).

Hence, in addition to differentiating between upgrading paths and ultimate outcomes, a difference has to be made between certain requirements and standards that have to be fulfilled to enter and remain competitive in particular global value chains (and thus related capabilities) and the development of capabilities that can be the basis for extra rewards (value captured). This differentiation is clearly a moving target in the context of high competition, and it is sector, global value chain, end markets and even lead firm specific. Firms in African countries often struggle to fulfill the former (capabilities to enter and remain competitive), with limited capacity to develop more pro-active strategies to simultaneously think about the latter (capabilities that lead to extra rewards).

Complexities of upgrading: deepening, diversifying and moving up or down?

Related to the above discussion, upgrading paths are complex and may involve important deepening and downgrading aspects as well as diversifying and moving up in the same or different value chains. And these aspects can happen in parallel. Deepening is of importance for the AfriCap project, given the low capabilities of most African-owned firms. In short, 'deepening what you already do' can be a successful firm-level strategy (Morrison et al. 2008), as well as a necessary one. Given the increasing requirements

demanded by lead firms in many sectors, firms in developing countries often need a lot of effort to deepen capabilities to fulfill these process and product requirements.

Downgrading can also be a successful and less risky strategy. For example, Gibbon (2008) shows in the Mauritius apparel export sector that downgrading to assembly production led to an expansion of orders for some firms and helped sustaining employment. In the South African wine industry, Ponte and Ewert (2009) note that producing simpler products at higher volumes and having a diversified product portfolio of high and low value products may be the most appropriate strategy to ensure the best outcome for local firms.[6] But in other global value chains, taking over new functions may be required to enter and remain in value chains. For example, European apparel buyers increasingly only work with full package suppliers that not only assemble apparel products but also are responsible for input souring, financing, and logistics. Further, the same firms may pursue multiple strategies at the same time. A study of apparel firms in Turkey by Tokatli (2013) shows that firms do not move into higher value-added activities and leave lower value-added ones behind. Rather, Turkish firms branched out in multiple directions without withdrawing from profitable activities, even if these were in the 'lower' parts of the value chain. Similar developments have been shown for the apparel sector in Central and Eastern Europe (Pickles et al. 2006; Plank and Staritz 2015).

Another important issue is the question of upgrading within one chain versus shifting to different chains. In his analysis of the apparel sector in Central American and Caribbean countries, Schrank (2004: 145) concludes that 'lateral movement into sparsely populated chains rather than upward movement in densely populated chains' is a more rewarding strategy. These different chains can involve moving into other sectors (inter-chain upgrading) when the existing chain has less rewards to offer, but it can also mean moving into other chains in the same sector linked to different end markets (end market upgrading) where the capabilities required to 'move up' may be lower and/or the rewards may be higher. Such end markets can include domestic markets and regional export markets, as well as emerging country markets that offer an alternative to the traditional European and US markets. This move does not require leaving the first chain, as multi-chain strategies can be most effective for upgrading and capability building. Hence, strategically linking different end markets and related value chains is important, as capabilities learned in global value chains could be also used in domestic and regional chains, and the other way around.

Particularly, regional and domestic markets might exhibit better growth and upgrading potential, particularly in terms of functional upgrading. Many case studies show that

[6] Another example is from the Taiwan computer industry, Acer decided it could upgrade by developing its own brand of computers and was successful doing so; its competitor, Mitac, initially opted to pursue an OBM (original brand manufacturer) strategy as well, but soon returned to OEM (original equipment manufacturer) where the profits were lower but more secure (Gereffi 1995).

functional upgrading to design and branding is much more pronounced in domestic and regional markets, as there are limits to this type of upgrading in global value chains. Navas-Aleman (2011) shows that Brazilian firms in furniture and footwear industries that operate in multiple chains (global, regional and domestic) show the best prospects in all kinds of upgrading. Studies of firms in the apparel global value chain across a range of countries also show that producing for domestic and regional markets has benefits. Pickles et al. (2006) show that apparel firms in East and Central Europe engaged in diverse strategies to manage opportunities and risks, which involved significant variation in how firms moved between export and domestic markets and across functions. For example, export assembly production can be combined with own-brand, own-label production for the domestic market. Plank and Staritz (2015) show similar developments for the Romanian apparel sector. For horticulture, Evers et al. (2014) show that regional supermarkets are increasingly important sales channels for fresh produce across East Africa, providing an important alternative to European supermarket-driven value chains.

Thus, firms can move into regional and domestic markets, they can develop their own products and brands for the domestic market while still manufacturing for others' brands in export markets, and they can expand their portfolios to include low-value products and higher value ones. They can 'upgrade', 'downgrade' and 'backslide' all at the same time, following a combination of trajectories in seeking rewards and minimizing risks, in cross-subsidizing activities within the firm, and in building capabilities related to different functions (Pickles et al. 2006; Tokatli 2013: 998). This shows that what makes sense as an upgrading strategy and related technological capability building is sector, global value chain, end market (and even lead firm), country and firm specific.

For a sector and country as a whole, upgrading and diversifying productive activities is however still important in the development process and this objective may hence collide with firm-specific up/downgrading or deepening paths. Supply chain upgrading that explicitly stresses the taking over of forward or backward linkages in the production process is a case in point. Global value chains allow concentrating on certain activities, not needing to develop a whole product or domestic industry and related capabilities. But the flip side of the coin is that it also comes with the danger of "thin integration" or "thin industrialization" (UNECA 2016). Entry into a new industry and its export markets generally starts by providing certain low value added production steps which in manufacturing sectors often involves assembly of imported inputs and in agricultural sectors involves export of unprocessed or minimally processed goods. In these cases, entry is associated with high levels of vertical specialization and generally low value added in exports and/or a high share of imports. Left alone, specialization in lower segments leads to limited skill and capability development in suppliers firms, and creates limited value added and linkages in the domestic economy. In manufacturing this type of integration can further lead to important competitiveness challenges as sourcing inputs domestically or regionally can be important in reducing costs and lead time and increasing

flexibility, as is the case in the apparel sector regarding textile inputs. Hence, limited supply chain upgrading within a firm or within the sector (as different firms might be involved in the inputs production segment) may be a challenge for supplier firms to remain competitive. This is particularly important as lead firms increasingly prefer one-stop shopping locations, where they can source a variety of products and inputs.

Conceptualizing Technological Capabilities within Global Value Chains

For locally owned firms in African countries, acquiring the basic production capabilities required to enter new export markets can be a challenge. This is particularly so for locally owned firms set up by first generation entrepreneurs, or entrepreneurs with no previous experience in manufacturing or agribusiness. In many African countries, there are often few productive sectors where locally owned firms have internationally competitive capabilities. Therefore, firms are not transferring capabilities from one kind of productive activity to another, but rather are engaged in the hard task of building basic technological capabilities from scratch, or applying skills developed from experience in producing for the domestic market, in order to produce for export. There are significant difficulties, costs and risks involved in investing and starting production in a new economic activity. Diaspora-owned local firms or local firms with a longer history in the sector may be the first to invest in new processes, products, and functions, but often in a gradual manner and thus slowly increasing the complexity of their technological capabilities. Relations between global export markets and regional and domestic markets can also be important, as well as relations to other business activities in the context of a diversified business that can buffer costs and risks for at least some time.

Therefore, it is important for the conceptualization and operationalization of technological capabilities to identify the capabilities necessary to meet the minimum requirements in specific global value chains as well as the capabilities needed to initiate more pro-active strategies in terms of processes, products, functions, end markets, or chains. In the latter, technological capabilities to generate and manage change pro-actively need to include the search for areas where rents, higher revenues, and less risks can be achieved, which can involve upgrading, downgrading, or different end markets and chains. Firms can change and/or add functions up- or downstream, or in several nodes of chains. They can diversify products and end markets, which can reduce risk, but also may require greater capabilities to manage a portfolio of different products, end market requirements and contacts. Low quality/price but high volume products can lead to capital accumulation that can subsidize the moving into higher value and more risky processes and products. Hence, what has to be considered is the balancing of rewards and risks and how this links to specific up- or downgrading or deepening paths.

We see these different paths as related to firm-level technological capabilities. Hence, it is firm-level technological capabilities that result in some firms upgrading and others not, and which cause and shape the particular kinds of upgrading paths that firms pursue. Related to the discussion on the complexity and ambiguity of upgrading paths, technological capability building has to be seen as nuanced and related to specific upgrading paths and their corresponding rewards, costs and risks as well as to specific local firm, industry and country contexts, and global value chain dynamics. In other words, our approach differs from the at least implicit underlying assumptions of most of the TC literature that building more capabilities is always good. As with upgrading, building capabilities has to be linked to the specific firm context and related costs. It may, for example, not make sense in the apparel sector to upgrade to the production of fashionable seasonal products that require short lead times and flexibility or to functionally upgrade to full package production given the non-existence local input supplies and trade-related infrastructure constraints that make importing costly and risky.

Coe and Yeung (2015) use the concept of the cost-capability ratio to describe capabilities in relation to costs of firms. They argue that firms achieve optimal ratios through cost reduction or building new capabilities, or both at the same time. Coe and Yeung present a matrix of cost-capability ratios in global production networks, where supplier firms enter in the low cost-low capability quadrant (firms with initial low capabilities and high costs are uncompetitive and cannot enter). Supplier firms generally move to the low cost-high capability quadrant, as high cost-high capability supplier firms can only survive in highly specialized products or services—otherwise they have to reduce costs. This may even require setting up production in another country with lower domestic costs, or bringing in cheaper labor to the home country. The Mauritian textile and apparel industry did all three, by offshoring apparel production to Madagascar, mechanizing production in the textile factories in Mauritius, and bringing in Bangladesh migrant labor to work in Mauritius apparel factories.

However, we also have some reservations to seeing capabilities only as relevant linked to specific contexts and in terms of capability-cost ratios. First, capabilities are the building blocks of structural change of the national economy and are in this regard in and of themselves important. On a more practical level, technological capabilities are needed to make any decision about strategies to pursue and up- or downgrading or deepening paths to follow in certain contexts. From this perspective, capabilities have a more fundamental role in being able to understand requirements, analyse contexts, and adapt strategies accordingly, which is required at any level of production in terms of functions and complexity.

Second, there is not always a clear dividing line between costs and capabilities, and costs can be reduced as a result of building firm-level capabilities. Hence, there is a dialectical

relationship. The TC literature acknowledges that firm-level capabilities are shaped by industry level and national level factors, and in this regard recognizes the costs limitations on firm-level capabilities. But costs related to the industry and national level – hence coming from first order constraints - can be reduced through industry or government actions. But to get those actions often requires that firms individually or collectively push to resolve issues that are causing higher costs or poor performance in terms of quality or delivery time. Firms engage in the process of pressuring the industry association or the government as part of building capabilities, as they come up against constraints. In this way, some aspects of costs and reducing costs relate to the firm-level processes of building capabilities. A good example in this regard is the push of Ethiopian apparel firms towards the government to provide financing mechanisms that allow for importing inputs for export production given the limited availability of suitable local textile inputs. This push was based on firms aiming, or being forced by their lead firms, to functionally upgrade to input sourcing. Without wanting or needing to acquire these new capabilities, the pressure on the government to resolve this issue would not have appeared.

These relations discussed above are captured in Figure 1, which differentiates between learning and technological capability building, up- and downgrading paths, firm level outcomes, and sector and country level outcomes. It shows that we define upgrading in a way that captures the idea of firm level paths, which involve different combinations of horizontal (deepening) and vertical upgrading (new products, functions, buyers, markets, chains). Upgrading paths lead to different firm level outcomes along the dimensions of income and risks, which coalesce into sector and country level outcomes. Figure 1 also shows that we see upgrading paths as related to firm level technological capabilities, as it is firm level capabilities that cause and shape the particular kinds of upgrading paths that firms pursue. In turn, firm level capability building and learning are influenced by firm-specific characteristics, local sector characteristics, the national policy and institutional environment, and global value chain dynamics.

Figure 1: Conceptualization of technological capabilities and upgrading paths

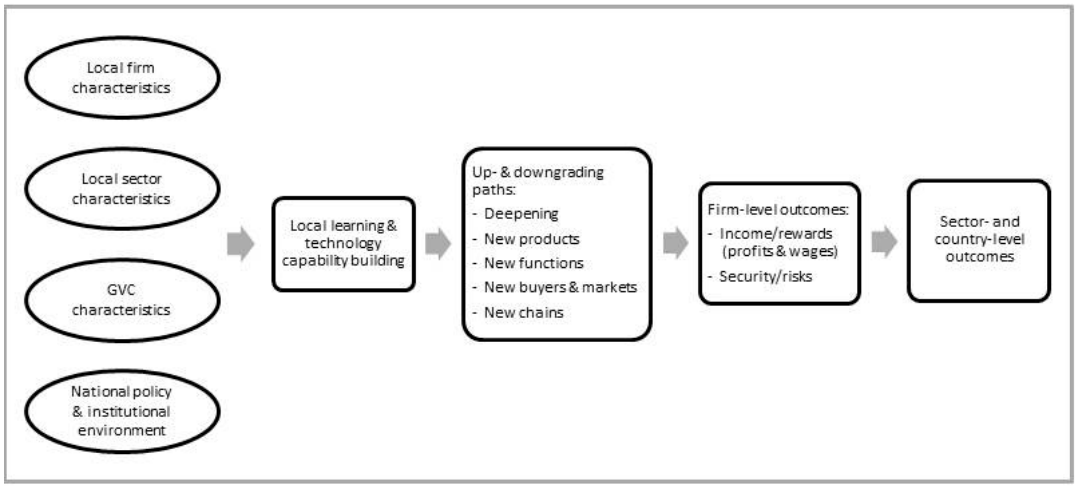

Table 1 presents a matrix template for describing the technological capabilities demanded to enter and to capture increasing value in a specific global value chain. The table has been adapted from the matrix presented by Lall (1992) to reflect the issues discussed related to upgrading within global value chains, and in particular to the kinds of global value chains analysed in the case studies of this project: apparel and floriculture.

Table 1: Matrix for Describing Global Value Chain-Specific Technological Capabilities

	Categories of Technological Capabilities						
Functional upgrading/ Complexity of TCs		*Investment*	*Product*	*Production process*	*Linkages/supply chain*	*End markets*	*Logistics, finance & support*
	Basic Production Capacity						
	Basic						
	Intermediate						
	Advanced						

The vertical axis of the table corresponds with functional upgrading, as moving to different functions in the value chain requires increasing and often more complex capabilities. Thus, each row indicates that firms are operating at a particular node in the global value chain. In this context, the elaboration of basic, intermediate, and advanced has to be done at the global value chain level and can include as much nuance, and thus as many rows, as deemed necessary to capture 'real world' trajectories in functional upgrading within specific industries. In our conceptualization, it is possible that one firm can operate at multiple nodes (rows).

The types of activities, or Lall's categories of technological capabilities, in each column have been modified to reflect what is important to entering and remaining competitive in global value chains, but also to reflect that firms can deepen and strengthen their capabilities within a specific node in a global value chain. Therefore, the descriptions of the capabilities required at each node in the global value chain (row in the matrix) will recognize that firms can put in increasing technological effort to search, learn and improve their capabilities, and thus there is an element within each row where firms move from the basic capabilities required to operate at that node to capabilities that create and manage technical change. Following Lall, the categories include investment, production,

and linkages, but the latter two have been elaborated to include the sub-categories process and product (production) as well as supply chain, end market, and logistics and finance (linkages). This can be linked to process and product upgrading as well as supply chain and end market upgrading.

In sum, our matrix takes into account the movement to new, upward segments or nodes in global value chains, which is represented though the rows, as well as technological deepening in the same segment or node of global value chains, which is represented through the columns. The latter includes process upgrading (the actual deepening), but also product, supply chain and end market upgrading. The latter three may correspond to movements along nodes/rows, or they may not. End market upgrading adds another dimension that complicates the picture, as different end markets require different technological capabilities.[7]

The technological capability matrix for our two global value chains, apparel and floriculture, are presented below. They were created based on the information collected and analyzed from existing literature on these global value chains, combined with our previous work on the apparel and floriculture industries.

Apparel GVC Technological Capabilities Matrix

The apparel matrix presented in Table 2 has five rows: CMT[8] subcontracting (equivalent to basic production capacity), CMT with direct buyer link, full package/free on board (FOB), original design manufacturer (ODM), and textile vertical integration (Gereffi 1999). The first step to enter apparel GVCs is often CMT subcontracting production. This is related to difficulties in establishing direct relationships with buyers and often involves subcontracting work for foreign owned firms, but may also include larger local firms with established buyer relationships. This involves generally three steps: cut, make, trim. The fabric is cut and bundled by style, size, and color; the different sewing steps are performed; and the finished products are trimmed, checked for quality control, and packed for shipment. A CMT supplier may also only fulfill the "make" step, but generally they do all three steps. Even these simple activities have to be fulfilled by complying with buyers' or first tier suppliers' process and product requirements, which already requires quite high capabilities with regard to production. These requirements include price, quality, reliability, lead times and flexibility, and fulfillment of specific process and product standards, as well as labor and environmental compliance.

[7] The focus of the matrix is the technological capabilities demanded in a specific global value chain, but we take into account that firms may at the same time supply different end markets, including domestic and regional ones that often require different and/or additional technological capabilities.
[8] CMT stands for cut, make, trim.

In this context, the first upgrading step is normally to ensure and deepen these capabilities and later on to diversify first tier suppliers and build direct links with buyers. The most important new activity in functional upgrading from being a subcontractor for a first tier supplier to establishing a direct link with buyers is generally pattern/sample making, which is critical for getting direct orders from buyers. This necessitates at least a small sampling room with a few good technicians that can provide samples at rather short lead times.

Within the category CMT, there can be quite a large variation among firms in terms of deepening capabilities. Deepening production processes is where firms will put most effort in the initial phase. This might also include investment in automatic cutting equipment, which can help improve quality and save on fabric consumption. But deepening capabilities also involves products, because CMT suppliers can be very different in terms of the complexity and variety of products produced. Hence, after deepening production processes, firms may diversify products before engaging in functional upgrading.

The next functional upgrading step involves full package, where the supplier purchases fabric and all other inputs required for apparel production, provides all production services, finishing, and packaging and is responsible up to loading onto the export carriers. The customer provides the design and often specifies textile suppliers. This requires no new functions in processes and products but additional functions in financing and managing the sourcing of inputs and part of the transport of inputs and outputs and being able to deal with related risks. Another additional activity that full package suppliers have to fulfill is pricing. Hence, these are new areas of capabilities that are not "simply learnt" on the way while being involved in CMT production. The shift from CMT to full package may be associated with the development of a domestic textile industry, as this makes input sourcing easier. If apparel exporters rely on imported inputs, then some financing mechanism to allow them to get access to foreign exchange and a working capital advance is required at the country level to allow for FOB operations.

The next step involves upgrading to ODM where the supplier is involved in the design and product development process, including the approval of samples and the selection, purchase and production of required materials. This again does not change much the capabilities required for the production process, but requires particularly new capabilities in product development and design, including investing in Computer Aided Design equipment and capabilities. ODM generally also requires more marketing skills, as own designs have to be actively sold to buyers with the aim to replace buyer design by own design products.

It is important to note that upgrading processes may often happen in parallel. For example, on the way to full package supplier, the deepening of production functions that are already

required for CMT production takes place. Further, diversifying to new buyers that more extensively demand product development and design services can be required, as the investment in these new capabilities needs to pay off. Hence, these investments and the related change in production set up can make it unprofitable for a firm to remain a CMT or full package supplier to other buyers.

The link to regional or domestic markets complicates this upgrading picture even further, as firms that supply these markets in addition to global export markets often fulfill different functions in these various markets. Often they are in charge of input sourcing and also design in the domestic market (with variation in regional markets) that require related capabilities. Hence, firms can be full package or even ODM suppliers in the domestic market and CMT suppliers in the global export market. They can even be involved in selling their own brands and in retailing in the domestic market alongside CMT export production.

The capabilities needed in different foreign export markets also vary significantly. EU buyers demand generally lower volumes, more complex products, higher flexibility, and broader capabilities in the area of product development and design. In contrast, US buyers demand larger volumes, stricter quality standards, and the ability to produce to buyer specifications. A share of EU and US buyers, particularly retailers, also increasingly demand full package capabilities from their suppliers. South Africa, an important regional market, follows EU requirements but with even smaller orders. US and EU buyers demand social compliance, but they have different standards. US buyers generally refer to WRAP, while EU buyers to BSCI. Regional and domestic buyers are generally less strict concerning social compliance or do not look at this at all.

With regard to supply chain linkages, there are several categories of inputs required in apparel production (Staritz and Frederick 2012): (i) direct raw material inputs (e.g., fabric and yarn); (ii) apparel trim and accessories (e.g., buttons, zippers, thread, elastic, labels, hangers); (iii) non-essential inputs such as packaging (e.g. cartons and poly bags); (iv) capital equipment and machinery parts; and (v) broad services applicable to a range of industries such as transportation, logistics, catering, IT, construction, cleaning, security, human resource, and training. Furthermore, there are possibilities for subcontracting linkages, where subcontractors perform a portion of assembly or finishing activities on behalf of the supplier. The most important supply chain linkages are to the textile sector, as fabrics are the most expensive input into apparel production and the quality of the textiles is directly related to the final product's quality.

The last functional upgrading step involves vertical integration into textiles. This generally does not take place in a sequence from apparel production to textile production, but rather most firms that are vertically integrated have always done textile along with apparel or started with textile and added apparel later. Textile (fabric and yarn) production

requires different capabilities: it is more capital-, skill-, and scale-intensive. For investments into textile production, a minimum scale is required due to its scale-intensive nature. Thus, a certain minimum size of the apparel industry, locally or regionally, is a requirement for textile investments, particularly in the woven segment. Further, access to finance is crucial for textile investment due to the capital-intensity of fabric and yarn production. Reliable and low-cost infrastructure is also more important for textile production, in particular with regard to electricity and water. Textile production requires more skilled labor with technical experience using industrial machinery as well as quality control personnel. Besides these issues related to local capabilities and the business environment, sourcing policies of buyers are also crucial to determine the extent of backward linkages into textile production. Many buyers require suppliers to import inputs from specified textile mills for their orders, which limits vertical integration or local linkage possibilities.

Table 2: Apparel GVC Technological Capabilities Matrix

	Investment	Production		Linkages		
(FUNUP)	**Investment**	**Process (PROCUP)**	**Product (PRODUP)**	**Supply chain (SCUP)**	**End market (EMUP)**	**Logistics, finance & support**
CMT – subcontracting	Selection of product(s) (knit/woven, complexity, fashion content, volume); Choosing location; Choosing machinery; Choosing size; Selection & training of workers (management, technicians, machinists); Negotiating contracts with utility & service providers (electricity, water, transport, etc.); Getting access to investment & working capital; Getting access to domestic first-tier supplier(s)	Controlling production costs (meeting price points, working capital/inventory management); Controlling quality (at end of line/multi stage in-line, fulfilling defect/reject rates); Controlling production reliability; Controlling production lead times & flexibility; Machinery, equipment & plant layout maintenance & improvements; Labor productivity improvements & continuous training; Compliance with safety standards; Compliance with labour & environmental standards	Producing according to sample received from first tier supplier; Fulfilling volume requirements (large/small); Increasing variety of products; Shifting to higher value products (complexity, fashion, lead times); Managing & improving volume flexibility; Investing in & improving finishing equipment	Links to other firms & collaboration in collective schemes; Participation in industry association	Managing relationship with first-tier supplier(s) (communication, negotiation, potential audits); Manage first-tier supplier diversification	Containing & re-negotiating contracts with utility & service providers (electricity, water, transport, etc.); Dealing with investment & working capital finance; Relation with training institutes; Relations with consultants; Link to state support institutions & participation in initiatives
CMT – direct buyer link	Getting access to export buyer(s) (contacts, trade fairs); Selection & training of workers with pattern/sample making skills; Selection & training of workers with buyer communication skills		Pattern/sample making based on buyers' design & specifications; Fulfilling sampling lead times	Assurance of systematic separation of buyers' inputs & finished products; Conformity to buyers' storage norms	Managing relationship with buyer (s) (communication/account management, negotiations, audits); Manage market diversification; Manage buyer diversification; Increase market intelligence gathering	
Full Package/FOB/OEM	Selection & training of workers with input sourcing, finance & textile/trim product skills; Getting access to input sourcing finance &	Controlling total supply chain costs (total inventory management); Controlling total supply chain lead times & flexibility; Supply chain management improvements		Managing input sourcing (fabric/yarn, trims/ accessories, packing material); Managing support service provision (embroidery, washing, dyeing, etc.);	Providing pricing & offer based on buyer request within short lead times	Managing input sourcing finance & related instruments (L/C); Managing part of transport of inputs & outputs (transport,

	related instruments (L/C)			Localization of input & service sourcing; Managing subcontracting linkages		logistics, customs clearance, etc.)
ODM	Selection & training of workers with design, product development & marketing skills; Getting access to design & product development finance		Investing in Computer-Aided Design (CAD) equipment; Design & CAD capabilities & provision of design services; Product development capabilities & management; Improvements in design & product development	Improving supplier relations & cooperation for product development	Offering & selling own design to buyer(s); Investing in market & buyer research	Managing design & product development finance
Textile	Selection of product (s) (knit/woven, yarn/fabric); Choosing location; Choosing machinery; Choosing size; Selection & training of workers (management, technicians); Negotiating contracts with utility providers; Getting access to investment & working capital & input sourcing finance	Controlling production costs; Controlling quality; Controlling production reliability; Controlling production lead time & flexibility; Machinery, equipment & plant layout improvements; Compliance with safety & environmental standards	Produce according to buyer requirements; Product development capabilities & management; Increasing variety of products; Shifting to higher value products; Add dyeing & laundry facilities; Access to or own laboratory for chemical tests	Links to other firms & collaboration in collective schemes; Participation in industry association (if textile specific); Managing input sourcing (cotton, other fibres); Managing support service provision (dyeing, laundry, etc.); Localization of input & service sourcing	Offering & selling apparel products with own textile inputs to buyer(s); Offering & selling to apparel firms in country or region if textile production higher than required for own apparel production	Containing & re-negotiating contracts with utility & service providers; Dealing with investment & working capital & input sourcing finance; Managing part of transport of inputs (transport, logistics, customs clearance, etc.); Relation with training institutes; Relations with consultants; Link to state support institutions & participation in initiatives

Floriculture GVC Technological Capabilities Matrix

In the floriculture matrix in Table 3, the columns illustrate that the production of cut flowers for export requires large investment capacity to set up production facilities (greenhouse, irrigation system, pack house), source inputs as well as hire and train workers in some basic skills. Along with finance, firms need access to cool chain logistics from farm to airport, cargo booking and handling services. The complexity of each category of capabilities increases depending on the targeted end market and the market channels. The direct sales marketing channel to the EU is considered to require greater capabilities, than the Dutch auction marketing channel. However, firms selling mainly via the Dutch auction may diversify or adjust their product, process and market strategies, which require new capabilities, rather than moving into direct sales to the EU. Selling to the Middle East, for example, is considered to require a lower level of capabilities than the Dutch auction marketing channel and is the easiest end market for firms to access. Thus, we include four rows in the floriculture matrix: basic production capacity, Dutch auction, strategic diversification, and direct sales (to EU markets).

To sell via the Dutch auction firms need to meet its stringent minimum requirements (related to plant health, quality sorting, grading, packing) that necessitate increasing capabilities beyond the basic production capacity that are identified in the first row. However, to strengthen their competitiveness and prices received in the auction channel, firms need to deepen their capabilities: expanding varieties, upgrade greenhouse and equipment; regularly train workers, improve product quality (stem length, head size, colour), production, harvest and post-harvest processes as well as to improve data recording and management information system. At the same time, firms should improve and control cool chain and logistics in order to prevent/minimize quality deterioration until the products reach the end market. They can also increase their market knowledge and ability to exploit services provided by the auction by collecting information on buyers as well as working on feedback from buyers regarding their quality and reliability. Although certification is not required by the auction, it is important to take on sustainability standards (B2B and/or consumer labels) that are most commonly adopted by competitors, such as MPS-ABC, GLOBALGAP, and FFP. Furthermore, ability to relate with breeders to get exclusive varieties is important to deepen capabilities within the auction channel, in order to meet the requirements of the dominant auction buyers (such as florists) that have higher demand for exclusive varieties and high value/quality products.

Firms selling to Europe primarily via the direct sales channel need to have greater capabilities to ensure consistency, reliability, and flexibility in terms of meeting buyers' specifications. Deepening capabilities in direct sales involves vertically integrated chain operations, especially in logistics and marketing, as well as adding more value on products such as delivering ready-to-use bouquets.

The two market channels (auction and direct sales) have their own advantages and disadvantages for exporters. The direct sale channel has limited tolerance for the learning-by-doing process compared to the auction. Despite that, successful integration into either of these marketing channels depends on meeting extremely high requirements, and some of those requirements in direct sales need more investment in building capabilities than in the auction. However, there seems to be no guarantee that the additional capabilities required in direct sales will be compensated with a higher price. Price is generally volatile in both marketing channels due the broader challenges facing the floriculture global value chain: reduced demand due to economic crisis, and high supply. Whenever price improves, it will be reflected in the auction. This might be why buyers and sellers in direct sales tend to observe the auction price during negotiations and price setting.

Weighing risk and reward, it seems to make sense for exporting firms to stick to the auction channel despite their level of capability. Instead of going for direct sales, firms can adopt a strategy of deepening their capabilities in the auction channel in order to increase their chance of fetching a higher price at the auction. Therefore, selling via direct sales might require higher capabilities than via auction, but using the latter is not necessarily an indicator of lower capabilities.

Strategic diversification relates to diversifying end markets as well as products, such as from flowers to fruits and vegetables. Considering transport costs and compliance requirements, firms might achieve a more competitive net price in regional market for similar quality products. Having alternative market channels also enhances local firms' bargaining position vis-à-vis their European buyers.[9] With the growing middle class in African countries, and other developing countries and emerging economies, and with the growing importance of supermarkets, strategic diversification should be seen with a lens that goes beyond the conventional definition of 'upgrading'. Rather the simultaneous process of continuously building capabilities with a notion of getting a 'better deal' needs to be emphasized.

[9] There is limited information in floriculture GVC literature about characteristics of relatively smaller but growing markets such as Middle East, but based on our experience of some exporting flower farms in Ethiopia, the market has much less stringent requirements than European market. Japan is one of destination of flowers from African countries, but like in the Middle East, there is limited study that gives detail information about the Japan market. However, it is relatively large market with growing interest in importing African flowers from Africa. However, its strict plant health related inspection procedure seems to put constraint to access the market.

Table 3: Floriculture GVC Technological Capabilities Matrix							
	Investment	**Production**			**Linkages**		
	Investment	**Product**	**Production process**	**Harvest & Post-harvest process**	**Logistics, finance & support**	**Supply chain**	**End market**
Basic production capacity	Selection of varieties, Choosing location & type of greenhouse and other equipment; construction of service blocks (pack house, stores)	Meet minimum quality req. of targeted market (e.g. Middle East)	Basic farm management system and data recording; hire and train managers & workers; meet Bronze-level requirements	Cutting at the right stage, at right length, at right position; transport to pack house; Defoliating, grading, bunching, trimming; packing; quality control systems; Cool chain on farm	Access to cool chain from farm to airport; access to cargo booking and handling services; access to finance; Link to state support institutions & participation in initiatives	Source varieties from breeders; Source quality packing materials, chemicals and fertilizers Links to other firms & collaboration in collective schemes; Participation in industry association	Find buyer; negotiate; build relations
Dutch Auction	Expand land holding (required to expand varieties); upgrade greenhouse technology; cool chain on farm; inventory and storage system; Conducive and safe working environment	Increase number of high value varieties, Increased certifications/labels & use for product differentiation, Improve vase life, packaging	MPS-ABC; CoP-Silver (Globalgap); Monitoring production process to improve efficiency & increase yields of products that meet specifications (stem length, head size), as well as re-evaluate/change production strategy; Increase training of staff; communicate human resources policy; Basic agricultural R&D.	Monitoring and improving all processes	Improve cool chain management; Increase reliability and consistency in delivery; Create own logistics company, or in collaboration with other firms Access to sector specific and other services	Relations with international consultants, breeders, foreign firms to discuss farm activities and gain knowledge; Collaborating in collective schemes to buy inputs, arrange transport logistics and handling; Vertical integration of upstream or downstream functions: packaging materials, propagating planting materials	Provide product information at acceptable level of accuracy; appear regularly on the auction clock; Appear on all auction days consistently score high in grading and reliability index Relation with auction service to improve grading score and reliability index Negotiate directly with buyers. Increase market intelligence gathering. Participating in trade fairs
Strategic diversification		Diversifying into non-flower products (fruits, vegetables, etc)	Farm management systems and staff training to deal with diverse production processes of new products.				New end markets: global (e.g. Japan), regional and domestic. Finding buyers and building relations; multiple marketing strategies
Direct Sales	Expansion—higher volumes required	Varieties dictated by buyer; packaging presentation, Ready-to-use bouquets	B2B and consumer Labels/certifications required.		Integrated cool chain management; just-in-time delivery		Own marketing & distribution centers

The technological capabilities matrix is a static picture: what it takes to be functioning within a global value chain, and what it means to be operating at different levels of functions and complexity. Upgrading is dynamic, so this static picture cannot indicate upgrading paths. The matrix is useful in operationalizing what technological capabilities mean for a specific global value chain. They provide a guide for assessing the status quo capabilities of a firm. But they can also be used to identify firms' upgrading and downgrading paths, by asking how firms got to their current position and changes over the past five or ten years, as well as the risks and outcomes of those changes. These issues on how to operationalize the matrix for assessing firms' capabilities and learning paths are discussed in more detail in the sector case study working papers analyzing the firm survey results.

Conclusion

The AfriCap project researches industrialization in African countries in the context of increasingly globalized production networks coordinated through transnational inter-firm linkages. African-owned firms often struggle to enter new export sectors in manufacturing and agro-processing, to remain competitive within them, and to capture greater value. AfriCap focuses on firm-level capability building and combines this firm level analysis with an understanding of global value chains and country-specific contextual factors. Such a technological capabilities approach to industrialization emphasizes the differences in the ability of firms to handle technologies and cope with technical change, when explaining the differences in economic performance across firms within the same sector, across sectors within the same country, and across countries. This approach offers conceptual tools for understanding firm-level processes of learning and capability building as well as how these firm-level processes are influenced and shaped by the specificities of the industry and global value chain in which they operate, as well as the national institutional and policy context, which shape such efforts and their outcomes.

This working paper has pursued two objectives. The first was to take up the call made by Morrison, Pietrobelli and Rabellotti (2008) to combine GVC, and related frameworks such as GPN, and TC theoretical approaches in order to better explain industrialization in developing countries in the context of increasingly globalized industries. The paper draws on the conception of technological capabilities from the TC literature, but adapts it to the context of global value chains and the specific requirements demanded and capabilities needed in this regard. It does so by drawing on the GVC and GPN approach and particularly the critical discussion on upgrading and identifying links between technological capabilities and the complexities of upgrading/downgrading and deepening paths and their relation to firm-level outcomes in terms of rewards and risks.

The second objective was to operationalize what technological capabilities mean in the context of specific global value chains, which is required before we can assess and map the capabilities of local firms in our cases of apparel and floriculture in Ethiopia, Kenya, and Madagascar. We need to know what technological capabilities are a prerequisite for participating in the apparel and floriculture global value chain as well as what it means to 'build' or accumulate capabilities in these global value chains. Using the matrices presented in this paper, we designed a firm survey for each global value chain and tailored it to the country context. The results of the surveys are analyzed in separate working papers, where we have grouped local firms into categories based on the level of their technological capabilities and their upgrading/downgrading paths.

The next step of the AfriCap project is to select firms from each category for in-depth research into the factors that shaped firm-level effort in learning and technological capability building and firm-level outcomes. On the conceptual side, we will use this empirical material to expand existing theoretical discussions regarding the factors that explain technological capability building and different firm-level trajectories. In doing so, we will focus on three learning channels: foreign direct investment linkages, buyer relations in global value chains, and industrial policy.

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